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Can placebo administered in the guise of caffeine reduce the misinformation effect?

Abstract: *Research suggests that placebo can reduce the misinformation effect. We aimed to examine for the first time whether placebo administered in the guise of caffeine can reduce the misinformation effect. One hundred and twenty-three healthy volunteers were randomly assigned to four groups in a 2 Placebo (Present, Not Present) × 2 Narrative (Misleading, Correct) study design. Participants from placebo groups drank 100 ml of placebo solution. They were told that it was water mixed with caffeine which could positively influence their memory. After three minutes, they watched a short movie clip as an original event and read a narrative with misleading details or correct details as a postevent information; they then completed a 22-item, two-alternative forced-choice questionnaire. The results reveal that the misinformation effect occurred. Although participants in the placebo with misinformation group scored better than participants who did not drink placebo and read the narrative containing misleading details, the difference was not statistically significant. Thus, it is concluded that placebo might not be enough to reduce the misinformation effect when it is administered in the guise of caffeine.*

Keywords: *memory, misinformation effect, placebo, suggestion*

Introduction

There is a lot of evidence that placebo can influence human performance and produce powerful effects (Benedetti, 2014). For example, placebo effects in sport performance are a well-documented fact. Athletes who ingested placebos in the guise of caffeine (Beedie, Stuart, Coleman, & Foad, 2006; Duncan, Lyons, & Hankey, 2009), anabolic steroids (Maganaris, Collins, & Sharp, 2000), carbohydrate (Clark, Hopkins, Hawley, & Burke, 2000), or amino acids (Kalasountas, Reed, & Fitzpatrick, 2007) performed their sport tasks better than controls. Placebos can also affect pain experience and induce an anaesthetic effect. People who were told that anaesthetic cream had been placed on their skin (Voudouris, Peck, & Coleman, 1990) reported less pain than those in control groups.

These broad effects of placebos can also be extended to cognitive performance. Results of a recent study by Rozenkrantz and colleagues (2017) showed that placebo can enhance creativity as participants in a placebo group showed more originality in creative tasks. Placebo was also found to increase IQ test results (Foroughi, Monfort, Paczynski, McKnight, & Greenwood, 2006) or general knowledge test results (Weger & Loughnan, 2013). Moreover, placebo was also found to be effective in enhancing performance in a Stroop-effect task, by either verbal suggestions (Raz, Kirsch, Pollard, & Nitkin-Kaner, 2006) or sham EEG (Magalhaes De Saldanha da Gama, Slama, Caspar, Gevers, & Cleeremans, 2013). There is also evidence that placebos can enhance memory. Parker and colleagues (2011) showed that an inert substance presented as a memory-enhancing drug improved performance in a prospective memory task. Similarly, placebo presented as a "drug with stimulant effect" was found to improve performance in a working-memory task in students (Ashor, 2011). Positive improvement on memory tasks induced

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by placebo was also observed in healthy seniors (Oken et al., 2008).

As placebos were found to be effective in sport performance, pain, cognitive tasks, and others, the question arises whether placebo can also influence the misinformation effect, i.e. a phenomenon which occurs when misleading postevent information can influence a subject's reported recollection of that event (Tousignant, Hall, & Loftus, 1986). Although only a few studies have been conducted so far on this topic, their results suggest that placebo can either reduce (Clifasefi, Garry, Harper, Sharman, & Sutherland, 2007; Parker, Garry, Engle, Harper, & Clifasefi, 2008) or increase the misinformation effect (Assefi & Garry, 2003). In both studies conducted by Clifasefi and colleagues (2007) and Parker and colleagues (2008), after administration of placebo, participants watched slides showing a man shoplifting some items from a bookstore. Then a 12-minute filler task began. When participants finished filler task, they read a summary containing several misleading details. The memory test contained 20 forced-choice questions. Both studies showed that participants who had drunk placebos scored better in memory tests. Both Clifasefi and colleagues (2007) and Parker and colleagues (2008) used placebos in the guise of R273, i.e. a drug that enhances mental alertness and cognitive functioning. Participants were told that R273 has a similar action as a drug used by the US army and they might expect to experience a variety of physical sensations as an effect of its administration. Next participants were weighted and watched a computer "calculating" the proper dose of R273 for them.

On the other hand, there is also evidence that placebos can increase the misinformation effect. Assefi and Garry (2003) administered placebo in the guise of alcohol drinks which participants drank while watching a movie. Then participants viewed a slide sequence presenting a shoplifting story. After 13 minutes of a filler task, participants read a misleading narrative. The memory test contained 19 forced-choice questions. Participants who had been told that they had drunk alcohol scored worse results in the memory test. However, Campo and colleagues (2012) did not find a difference in susceptibility to the misinformation effect between participants who drank real alcohol, participants who were administered placebo and were told that they had drunk alcohol, and participants from the control group. Thus, future studies are needed to determine whether placebo can increase the misinformation effect.

Previous studies on placebo and the misinformation effect (Assefi & Garry, 2003; Clifasefi et al., 2007; Parker et al., 2008) used a standard, three-stage procedure (Loftus, Miller, & Burns, 1978) to induce the misinformation effect and used slides as the original event. In misinformation studies the original event can also be presented as a video clip (Ihlebaek, Love, Eilrtsen, & Magnussen, 2003; Loftus, Levidow, & Duensing, 1992; Sutherland & Hayne, 2001). Events presented as video clips are much more related to real-life events when people observe specific situations in motion, not as series of snapshots. Thus, videos are much more accurate at simulating witnesses' situations in the real world. We aimed to find out whether placebo in the guise of caffeine can reduce the misinformation effect. Moreover, we decided to present the original event as a short video clip instead of the slides that were used in the aforementioned studies.

Previous studies on placebo and the misinformation effect used placebos in the guise of a drug that enhances mental alertness and cognitive functioning (Clifasefi et al., 2007; Parker et al., 2008) or alcohol (Assefi & Garry, 2003; Campo et al., 2012). Generally, there is a lot of evidence that it is not the form of placebo but the verbal suggestions that accompany its application that induce expectancies and – as a consequence – the placebo effect (De Pascalis, Chiaradia, & Carotenuto, 2002; Montgomery & Kirsch, 1996; Pollo et al., 2001; Vase, Riley, & Price, 2002). We decided to use placebo in the guise of caffeine together with a verbal suggestion that caffeine improves memory skills. We assumed that caffeine would elicit strong expectations about memory enhancement as caffeine has its own associated expectations. For example, Peeling and Dawson's (2007) study showed that after ingestion of caffeine students believed that their ability to learn during lectures increased. In fact, caffeine can enhance short--term memory (Christopher, Sutherland, & Smith, 2005; Haskell, Kennedy, Wesnes, & Scholey, 2005) and memory performance in college students (Capek & Guenther, 2009; Sherman, Buckley, Baena, & Ryan, 2016). This is in line with studies which show that caffeine is widely used by Polish college students while studying and doing cognitive tasks (Garus-Pakowska, Jakubowska, Gaszyńska, & Szatko, 2015; Kopacz, Wawrzyniak, Hamułka, & Górnicka, 2012; Michota-Katulska, Zegan, Sińska, & Kucharska, 2014).

The results of previous studies have shown that ingestion of placebo in the guise of caffeine can enhance sport and cognitive performance (Shabir, Hooton, Tallis, & Higgins, 2018). For example, no difference in cognitive performance has been found between participants who were administered two doses of caffeine and participants who were administered only one dose of caffeine and one dose of placebo in the guise of caffeine (Sun, Zhang, He, Liu, & Miao, 2007). Moreover, there is evidence that placebos in the guise of caffeine can enhance memory skills (Kelemen & Creeley, 2003), have a similar influence on verbal memory as caffeine itself (Mednick, Cai, Kanady, & Drummond, 2008), and that there seems to be no difference between the influence of caffeine and placebo administered in the guise of caffeine on memory (Oei & Hartley, 2005). It should be also noted that there is a link between attention-related processes and susceptibility to the misinformation effect, i.e. lower engagement in attention processes is associated with an increase in susceptibility to the misinformation effect (Kiat, Long, & Belli, 2018; Lane, 2016; Rivardo et al., 2011; Zaragoza & Lane, 1998). Thus, another reason that we aimed to use placebo in the guise of caffeine is the evidence that not only caffeine enhances participants' attention, but also expectations induced by the fact that they have ingested a caffeinated drink may play an important role (Dawkins, Shahzad, Ahmed, & Edmonds, 2011).

In line with previous studies on placebo and the misinformation effect (Clifasefi et al., 2007; Parker et al.,

2008), we applied a standard, three-stage procedure (Loftus et al., 1978) to induce the misinformation effect, but instead of slides participants watched a short action movie clip.

Method

Participants

One hundred and twenty-three healthy volunteers participated in the study, including 28 males and 95 females. They were undergraduate students, aged about 21 years ($M = 20.91$, $SD = 3.54$). They were asked to participate in a study on the influence of caffeine on memory. They were randomly assigned to one of four groups: misinformation with placebo ($N = 30$), misinformation without placebo ($N = 30$), correct placebo (without misinformation) ($N = 33$) and control group (without placebo and misinformation) ($N = 30$). To keep the sample size equal in all study groups, block randomization was used (Suresh, 2011). All the participants were healthy; none of them had any contraindications for caffeine intake. Having informed them that they could stop participating in the study at any point without providing a reason for their withdrawal, participants gave their informed consent to participate in the experiment. No compensation was offered for participation in the study.

Materials

The placebo was a calcium tablet (400 mg) dissolved in 1.5 litres of still mineral water. It was administered in 100 ml doses in plastic cups. A three-minute clip taken from the action movie "The Bourne Identity" by Doug Liman was used as the original event. The chosen scene showed the main character escaping from the United States consulate. It starts when he has disarmed three consulate workers, he then goes up the stairs to the highest level of the building followed by a heavily armed police squad; finally, he tries to climb on the roof from a balcony but fails. As postevent information, a short narrative was used. The narrative described chronologically what happened on the movie clip and contained several details about the events and actions. Two versions were prepared: control (with accurate information) and misleading (with 11 misleading details). The misleading details were prepared according to Pezdek and Roe's (1997) classification of misleading details: changed detail (detail *X* is perceived in the original event, but *Y* is suggested in the postevent information), erased detail (detail *X* is perceived in the original event, but it is suggested in the postevent information that *X* was not perceived) and planted detail (detail *X* is not perceived in the original event, but it is suggested in the postevent information that *X* was perceived). The narrative in the misleading version contained two planted details (e.g. United States flags were present in the movie clip, but George Washington's portrait and U.S. flags were suggested in the narrative) and nine changed details (e.g. the main character threw a gun into a trash bin in the movie clip, but a window was suggested instead of a trash bin in the narrative). We did not aim to include the erased details in the postevent information as erasing details are less effective in the induction of the misinformation effect than changing them (Pezdek & Roe, 1997). To test for participants' memory of the original event, a 22-item pen and paper questionnaire with a two-alternative forced choice was used. The questionnaire contained eleven filler questions which were not relevant for the experimental manipulation and eleven critical items (e.g. How did the main character get rid of the gun? A. He threw it into a trash bin, B. He threw it out of a window). As a filler task, a Polish adaptation of the Squire Subjective Memory Questionnaire (Squire, Wetzel, & Slater, 1979) was used (Kuczek, Szpitalak, & Polczyk, 2016).

Procedure

A 2 Placebo (Present, Not Present) × 2 Narrative (Misleading, Correct) study design was applied. Groups were as described: misinformation with placebo, misinformation without placebo, correct placebo (without misinformation) and control group (without placebo and misinformation). In general, the procedure was similar among all groups. At the beginning of the experiment, participants from groups with placebo drank 100 ml of placebo. They were told that they were drinking water mixed with caffeine, which could influence their memory skills. They were also asked to wait for three minutes to let the caffeine take effect. Meanwhile, participants were instructed about the next steps of the study. In groups without placebo at the beginning of experiment, participants were instructed about the steps of the study instead of drinking placebo. The next steps of the procedure were the same among all groups. The short action movie clip (the original event) was shown with the use of a projector, preceded by the following instruction: "Now, we will see a short action movie clip which will take about three minutes. Please try to remember as many details as possible". Next, participants did a 10-min. filler task and then read a short narrative (postevent information) which either contained eleven misleading details (in the misinformation with placebo group and the misinformation without placebo group), or which did not contain any misleading details (in the correct placebo group and the control group). Then, without any break or a filler task they took a 22-item, two-alternative forced choice questionnaire using pen and paper. They were forced to choose between details shown in the movie clip and the misleading details contained in the narrative they had read. When the study was completed, the participants were fully debriefed.

Results

Statistical analysis was conducted with IBM SPSS Statistics 24. Two-way analysis of variance was used with a significance level of 5%. This was followed by planned comparison tests between the results of the misinformation with placebo, misinformation without placebo, correct placebo and control groups. The dependent variable (memory of the original event) was calculated based on the score of correct answers for critical items in the questionnaire (Table 1).

Table 1. Means and standard deviations of number of critical items correctly answered in the questionnaire for each group

Group	*M*	*SD*
Misinformation with placebo	7.93	1.57
Misinformation without placebo	7.30	2.18
Correct placebo	7.90	1.64
Control	9.07	1.20

A statistically significant main effect of narrative was found ($F_{(1, 119)} = 7.91$, $p < .01$, $\eta^2 = .06$). Figure 1 shows that participants who read the narrative which did not contain misleading details gave more correct answers to critical questions in the questionnaire than participants who read the narrative which contained misleading details. No significant main effect of placebo was found ($F_{(1, 119)} = .76$, $p > .05$, $\eta^2 = .006$), therefore it seems that placebo did not improve participants' memory of the original event. However, a statistically significant interaction effect between placebo and narrative was found ($F_{(1, 119)} = 8.53$, $p < .01$, $\eta^2 = .06$). The planned comparisons test between the misinformation without placebo group and the control group (without placebo and misinformation) revealed that there was a statistically significant difference between these groups in the number of correct answers for critical items ($t(61) = -4.01$, $p < .001$, $d = 1.12$), i.e. the misinformation effect was found. Similarly, the planned comparisons test between the misinformation with placebo and control groups revealed that there was a statistically significant difference between these groups in the number of correct answers for critical items ($t(58) = -3.135$, $p < .01$, $d = 0.8232$), i.e. the misinformation effect was also found. Also, the planned comparison test between the correct placebo group and the control group revealed that there was a statistically significant difference between these groups in the number of correct answers for critical items ($t(58) = -3.134$, $p < .01$, $d = .8230$), i.e. participants in the control group scored better than participants in the correct placebo group. Figure 2 shows that participants who were administered placebo and read the misleading narrative had a better memory of critical details of the original event than participants who read the misleading narrative but did not drink placebo. The planned comparisons test revealed that there was no statistically significant difference between these groups in the number of correct answers for critical items ($t(61) = 1.3$, $p > .05$, $d = .30$). Participants from both the misinformation with placebo and the misinformation without placebo groups had worse memory of critical details of the original events than participants in the control group (without placebo and misinformation).

Discussion

Participants who had read the narrative with misleading details answered less correctly to critical items in the memory test than participants who had read the narrative without misleading details. Thus, the misinformation effect was found; this is in line with many previous studies in which the misinformation effect was induced with the three-stage procedure (Loftus, 1975; Loftus et al., 1978; Tousignant et al., 1986; Chambers & Zaragoza, 2001). However, we did not find evidence that placebo reduced the misinformation effect. Regardless of whether they received placebo or not, participants from both misinformed groups scored worse in memory test than the control group. Moreover, although participants who drank placebo and read the narrative with misleading details seemed to score better in memory test than those who were not administered placebo but who also read the narrative with misleading details (Figure 2), this difference was not statistically significant. Thus, it is concluded that placebo administered in the guise of caffeine might not be enough to reduce the misinformation effect, contrary to the results of previous studies in which placebos

Figure 1. Mean number of critical items correct in the questionnaire depending on the type of narrative (with correct details versus with misleading details)

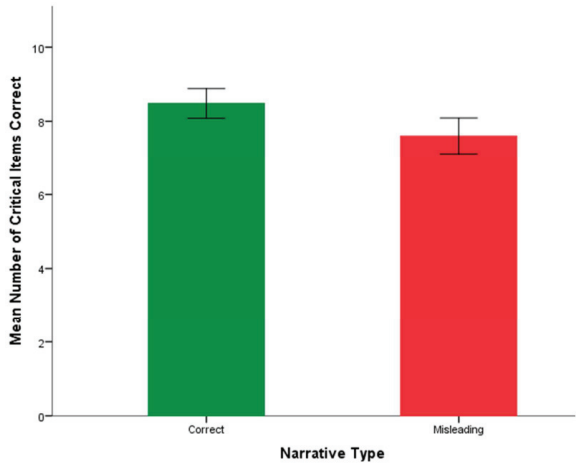
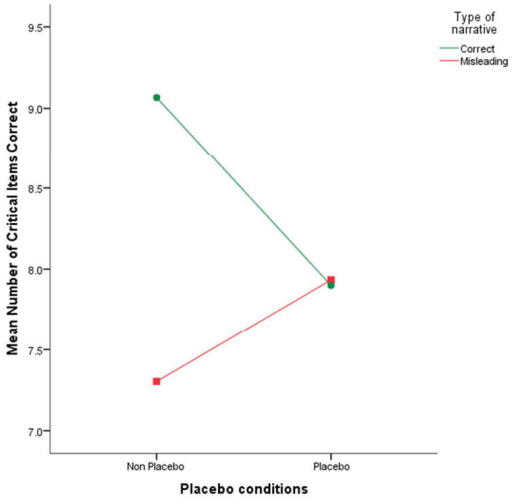


Figure 2. Mean number of critical items correct in the questionnaire depending on the study conditions



were administered in the guise of cognitive-enhancing drugs (Clifasefi et al., 2007; Parker et al., 2008).

Kirsch and Lynn (1999) suggested that placebos make people behave in a certain way which produces the effects they misattribute to placebo. In other words, people adjust their behaviour to suggestions and expectations; they then attribute the effects of such behaviour to the action of placebo. According to this account, placebo reduces the misinformation effect when people make behavioural adjustments to suggestions they have received and their expectations. Studies have proved the role of cognitive factors in the induction of the misinformation effect (Loftus, 2005). One of these cognitive factors is source monitoring, which is a set of processes involved in making attributions about the source and origin of information (Johnson, Hashtroudi, & Lindsay, 1993). This is a very important factor which helps people to detect discrepancies between the original event they saw and the postevent narrative they read. Previous studies on placebo and the misinformation effect (Clifasefi et al., 2007; Parker et al., 2008) have suggested that better source monitoring was responsible for reducing the misinformation effect. Indeed, there is some evidence that improved source monitoring can reduce the misinformation effect (Chambers & Zaragoza, 2001; Johnson et al., 1993). Based on the results of these studies, we expected that administration of placebo in the guise of caffeine would increase participants' attention, cognitive effort and their source monitoring processes.

Our results contrast with previous studies which showed that placebo could reduce the misinformation effect (Clifasefi et al., 2007; Parker et al., 2008). In our study, placebo was administered in the guise of caffeine mixed with water, and participants were told that caffeine would improve their memory skills. We speculate that the suggestion used in our study was not strong enough to elicit expectations of enhanced memory performance. Stronger suggestions were used in previous studies. There are several features which make those suggestions stronger than in our study. First, in the previous studies placebo was used in the guise of sham drug R273, which enhances mental alertness and cognitive functioning. Participants were told that R273 is a very close "cousin" of a similar drug which was used by U.S army radar operators and "significantly improves the ability to detect changes in the visual field and quickly and accurately distinguish enemy target signatures from simple environmental noise" (Clifasefi et al., 2007, p. 114). Second, participants were also weighed so the computer could "calculate" the proper dose for them. Third, the experimenter told participants that they might experience a variety of physical sensations. On the other hand, participants in our study probably had some previous experiences with caffeine and some expectations about its effects on their cognitive skills. Moreover, usually caffeine is ingested in the form of coffee or caffeinated energy drinks, not in the form of caffeinated water. Thus, the form of placebo used might have decreased participants' expectations of the effectiveness of placebo. Thus, our suggestion might not have convinced them that caffeine would improve their memory skills. As a result, participants might not have adjusted their behaviour to the suggestion, i.e. they might have shifted from heuristic, quick source monitoring to more effortful, slower source monitoring (Chambers & Zaragoza, 2001). In other words, our suggestion was not strong enough and insufficiently convincing to make participants focus more on the original event, process details from the movie clip and from the narrative in a more effortful and careful way, and detect discrepancies between them. In effect, they did not detect misleading information more easily, which did not prevent them from distorting their memories of the original event (Tousignant et al., 1986). Moreover, participants in the control group scored better in memory test than participants in the correct placebo group. We speculate that the suggestion we used might not have been strong enough to convince participants to make cognitive effort, not only to process details and detect discrepancies between them, but also to focus attention on remembering an original event.

Our results are in line with other studies which show that suggestions which elicit low expectancies produce lower placebo effects than suggestions which produce strong expectancies (Geers, Wellman, Fowler, Rasinski, & Helfer, 2010; Price et al., 1999; Schneider et al., 2006) and very subtle suggestions are not enough to produce any placebo effect at all (Geers, Helfer, Weiland, & Kosbab, 2006; Rosen, Kirsch, Kaptchuk, Ingvar, & Jensen, 2017). We speculate that if we had used as strong suggestion as in previous studies (Clifasefi et al., 2007; Parker et al., 2008), placebo in the guise of caffeine might have been enough to reduce the misinformation effect.

On the other hand, our results might be caused by the nature of the original event that we used. Videos capture more information than slides, so participants in studies which used videos were exposed to much more information that they needed to remember. In one previous study (Parker et al., 2008), 62 slides appeared for 2.5 seconds each, so participants had more time to focus their attention on specific details and remember them, compared to participants in our study who watched a video clip with thirty frames per second. As a result, participants might have remembered fewer details and might have been more susceptible to the misinformation effect. In light of the fact that previous studies used only static slides, we speculate that an original event presented as a video clip might have contributed to the ineffectiveness of placebo used in this study. As we did not include a group with an original event presented as slides in the current study, future studies should focus on the possible differences between an original event presented as static pictures and as a video.

One of the main advantages of our study is the large sample size. A total of 123 people participated in the study, more than in any previous study on the influence of placebo on the misinformation effect using a 2 × 2 design (Clifasefi et al., 2007; Parker et al., 2008). However, some limitations of our study should be also acknowledged. Most of the participants were females (95, 77%) and they were young (mean age: 21), so the results of our study

cannot be easily generalized to the entire population. Moreover, in the current study caffeine drinking habits were not controlled for and might have influenced participants' expectations of the effects of caffeine. Moreover, some participants might have ingested caffeine prior to participation in the study. Future investigations on the influence of placebos administered in the guise of caffeine on the misinformation effect should also include a group in which placebo is administered without any suggestions.

However, our findings might have some important practical implications. We found that placebos with subtle suggestions are not sufficient to reduce the misinformation effect when the original event is presented in the form of video, which is much more related to real-life events than slides. This raises some questions: Can placebo in the guise of caffeine reduce the misinformation effect? Can placebo reduce the misinformation effect when the original event is presented in a form other than static pictures? Can placebo with strong suggestion reduce the misinformation effect when the original event is presented in motion? These questions are open for further investigation.

Disclosure statement

No potential conflict of interest was reported by the authors.

Ethical statement

The work conforms to Standard 8 of the American Psychological Association's Ethical Principles of Psychologist and Code of Conduct.

Data availability statement

The data that support the findings of this study are openly available in Open Science Framework (OSF) at http://doi.org/10.17605/OSF.IO/M7N98.

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